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Forest Service  
Northeastern Area  
State and Private  
Forestry

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Department of  
Conservation and  
Natural Resources

Commonwealth of  
Pennsylvania

September 2004

# **The State of the Forest:**

## **A Snapshot of Pennsylvania's Updated Forest Inventory 2004**





Dear Pennsylvanian,

Pennsylvania is truly blessed with forest ecosystems that provide clean water, recreation opportunities, plant and animal habitat, and valuable wood products—all critical to healthy and sustainable communities. This publication provides a snapshot of a new U.S. Forest Service/DCNR Bureau of Forestry inventory of Pennsylvania's forests and serves as a foundation for future reports on our State's forest conditions.

Some of the statewide inventory results are positive and reflect many opportunities—such as no net loss of forestland and increasing timber volumes. There is, however, cause for concern. The results clearly identify a regeneration problem in our forests. Most experts agree that white-tailed deer overbrowsing is the primary reason. The Commonwealth is at a critical juncture in the long-term management of our extensive and valuable forest. The lack of regeneration could have a dramatic impact on the future economic and ecological condition of our forestland.

We plan to publish future reports focusing on different regions of the Commonwealth, as well as a variety of issues facing our environmental community. I encourage you to think critically about the information discussed in this report and to participate in an ongoing dialogue to develop strategies for managing forests to meet our current needs as well as those of future generations.

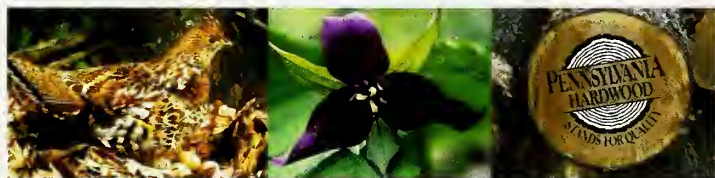


Dr. James R. Grace

Sincerely,

A handwritten signature in black ink that reads "James R. Grace".

James R. Grace  
Director, Bureau of Forestry



## Highlights

- Statewide, there was no net loss of forestland. However, certain regions of the Commonwealth are losing forestland to sprawl and development.
- Private entities own 69 percent of Pennsylvania's forests, while public agencies own 31 percent.
- Red maple is Pennsylvania's most abundant tree species. Black birch had the largest increase in tree numbers, surpassing black cherry as Pennsylvania's second-most common tree species.
- Tree regeneration is severely lacking and half of Pennsylvania's forests are at risk of regeneration failure, due mostly to white-tailed deer overbrowsing.
- Board foot volume continues to increase. Since the 1989 inventory, all major species increased in volume except sugar maple and eastern hemlock.

## An Improved Forest Inventory Process

The USDA Forest Service's Forest Inventory and Analysis (FIA) program completed periodic forest inventories in Pennsylvania in 1955, 1965, 1978, and 1989. FIA and the Bureau of Forestry implemented a new system in 2000 that improves upon previous inventories by including yearly updates and collecting additional data to provide timely information on Pennsylvania's forest conditions. Field measurements taken during a 5-year cycle on roughly 5,000 plot locations distributed on both public and private forestland provide the data for the inventory.

This publication is a snapshot of the results from the first 3 years of the inventory and will serve as a baseline for subsequent reports, which will address a wide range of forest-related issues and include references to other research conducted on Pennsylvania's forests. Please refer to the back cover of this report for a listing of future topics and information on how to obtain a complete copy of the latest FIA report for Pennsylvania.



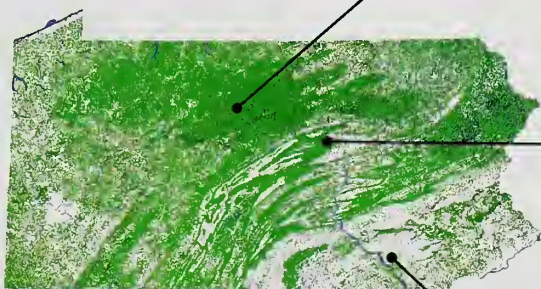
## Forests Dominate Pennsylvania's Landscapes

Forests are common in landscapes across much of Pennsylvania. Forested ridges and scattered woodlots mixed with farmland in the valleys characterize most of southeastern, south-central, and western Pennsylvania.

Three public agencies—DCNR, the Pennsylvania Game Commission, and the USDA Forest Service—own and manage a significant portion of the forestland across Pennsylvania's northern tier, constituting some of the most remote forestland in the Eastern United States.

## Much of Pennsylvania's Forestlands are Privately Owned

While public forestland abounds in north-central Pennsylvania, most of the forestland throughout the State is privately owned (69 percent). Concurrent with the forest inventory is a survey of Pennsylvania forest landowners. In previous surveys, forest owners cited a wide range of reasons for owning land, including income and investment potential, recreation, peace and solitude, and providing wildlife habitat. The management of these private forests has important economic and ecological implications. Understanding forest ownership dynamics as well as landowner attitudes and intentions is critical for developing sustainable land use policies and forest management recommendations. Future reports will contain additional information on Pennsylvania's private forestlands as well as results of the landowner survey.



*Public forestland abounds in north-central Pennsylvania.*



*Forested ridges and agricultural valleys characterize central Pennsylvania.*



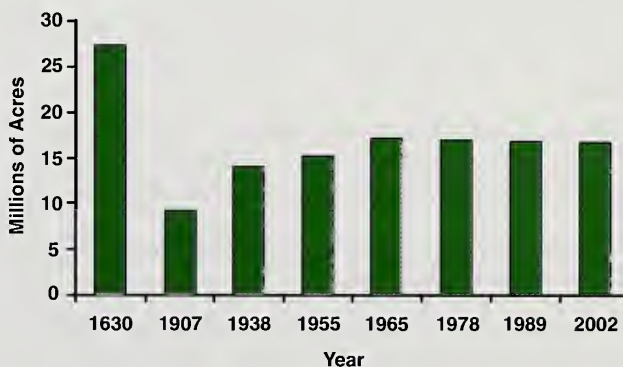
*Urbanized areas such as Harrisburg contain fragmented forests.*

## Forestland is Stable Across Most of Pennsylvania

In 1630, forests covered an estimated 95 percent of Pennsylvania. Then, beginning in the mid-1800s, nearly all the forests in Pennsylvania were harvested by the developing nation for agriculture and wood products. The area of forestland reached an all-time low of about 30 percent in 1907.

Since the early 1900s, the forests have recovered and total forestland area appears stable. The current inventory shows no net loss of forestland statewide. Today, forests cover about 58 percent of the land area in Pennsylvania, totaling 16.6 million acres, compared to 16.8 million acres and 16.7 million acres in 1978 and 1989, respectively. However, certain portions of Pennsylvania, especially the southeast and south-central regions, are losing forestland to sprawl and development. Regional analyses to determine changes in forestland area are underway and future reports will provide insights as data become available.

**Pennsylvania Forestland Area by Year**



*Photos by Bureau of Forestry*



## Pennsylvania's Forests Are Largely Even-Aged

The photograph sequence on the left was taken at the same location on the Allegheny National Forest in northwestern Pennsylvania. The photographs illustrate how the forest regenerated naturally and developed after widespread harvesting in the late 1800s and early 1900s. Since this harvesting activity happened over a relatively short time period, most of the trees that regenerated into today's forests are roughly the same age, on average between 80 and 120 years old. This type of forest, where most of the trees are similar in age, is referred to as an "even-aged" forest.

In addition to age, tree size (diameter) is another important consideration of even-aged forests. While the trees in a forest might be similar in age, they usually vary greatly in diameter, as depicted in the photograph sequence on the left. Due to variation among species, soil and site conditions, and genetics, trees of the same age in the same forest often exhibit large differences in growth rates. Therefore, tree diameter is not always a good indicator of tree age. Consequently, harvesting the largest trees

to leave behind the smaller, "younger" trees does not provide a healthy future forest canopy. Harvesting the largest trees from a forest often removes the healthiest and fastest-growing trees and leaves behind inferior and slower-growing trees. Much of the data presented in this report reflect that Pennsylvania's landscape is composed of many even-aged forests.

White-tailed deer were another significant factor affecting the development of Pennsylvania's forests. When today's even-aged forests originated in the early 1900s, Pennsylvania's white-tailed deer population was at an all-time low—thousands of animals or less—suggesting that deer browsing did not inhibit forest establishment and early growth. This vastly contrasts the situation today. The population is at an all-time high and the estimated 1.6 million white-tailed deer are severely limiting forest regeneration, establishment, and understory development. For example, notice the lack of vegetation growing in the forest understory in the 1998 photograph.



*Photos by USDA Forest Service*

## Large Trees Dominate Pennsylvania's Forests

Forest structure and composition refer to the mixture of tree sizes (height and diameter), tree species, and other characteristics, such as standing and fallen dead trees and other plants that make up the forest. Forest structure and composition are important ecological indicators, particularly for describing wildlife habitat conditions.

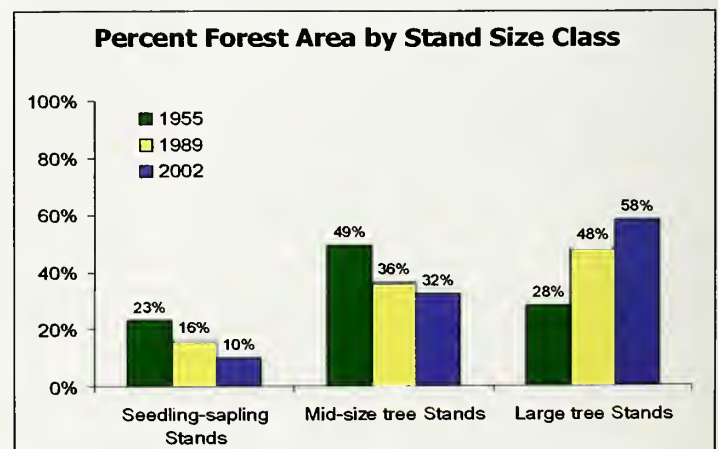
One method for describing forest structure is to classify the forest based on the predominant tree size in a particular area or "stand." Three commonly used categories for describing tree diameter are:

**Seedling-sapling** = tree measuring less than 5.0 inches in diameter at breast height (DBH).

**Mid-size tree** = tree measuring 5.0 inches DBH to 9.0 and 11.0 inches DBH for softwoods and hardwoods, respectively.

**Large tree** = tree measuring greater than 9.0 and 11.0 inches DBH for softwoods and hardwoods, respectively.

The graph below shows the historic and current stand size class distribution (by tree diameter) for Pennsylvania's forests.





Currently, seedling-sapling stands account for 10 percent of the forestland area, stands of mid-size trees occupy 32 percent of the forestland, and stands of large trees dominate the landscape, representing 58 percent of the forest base.

The distribution of diameter-size classes is constantly changing. Prior to European settlement, the forest was a mosaic of conditions including both even- and uneven-aged forests that were affected by natural disturbances, such as wind and ice storms, as well as disturbances caused by Native Americans. Since the early 1900s, the percentage of forestland classified as large-tree areas has increased, while the percentages of both seedling-sapling and mid-size tree areas have decreased. Although this trend follows the natural progression of forest growth as shown in the photograph sequence, it is of some concern. Many experts agree that Pennsylvania should contain a more balanced mixture of diameter-size classes, specifically, additional acres in the seedling-sapling class, which is important for wildlife species requiring early successional habitat.

Balancing the area of young and old forests across the landscape is a complicated ecological consideration, since certain wildlife species prefer young forests while others benefit from older forests. Uneven- or multiple-aged forest stands, as well as late-successional old growth forests each provide unique habitats for plants and animals. Only a very small percentage of Pennsylvania's forests are late-successional old growth, since most of the forests were completely cut-over about 100 years ago.

While this report cannot provide a complete discussion about the importance of tree age and diameter, future reports will address these concepts and issues in further detail.

## Tree Species Composition is Changing

Pennsylvania's forests support a wide variety of tree species—the latest inventory recorded over 100.

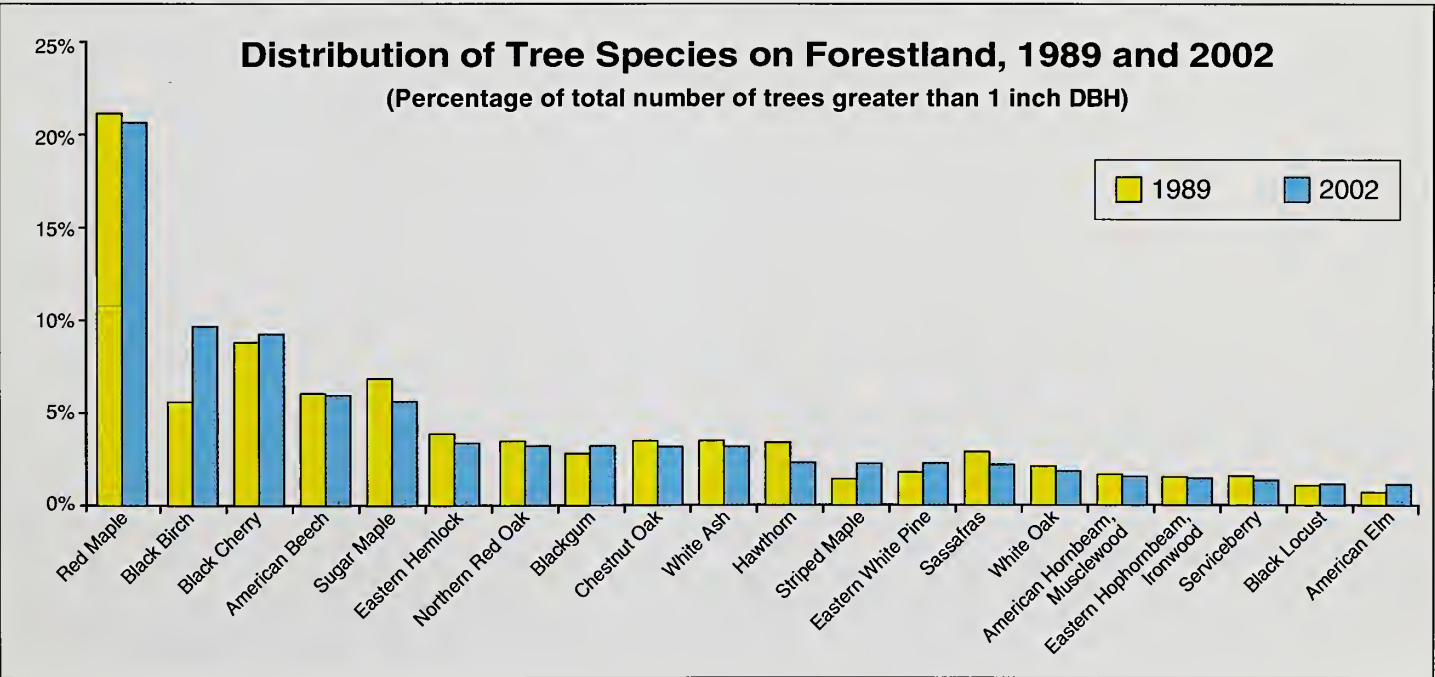
Species composition is an extremely important indicator of forest health and condition. Diverse forests with many different tree

species provide an assortment of food (e.g., acorns, cherries, and beechnuts) for wildlife, and are generally more resilient to impacts from insects, diseases, and invasive species. Additionally, species composition can have economic implications.

Pennsylvania hardwoods such as black cherry, red oak, and sugar maple are in demand worldwide for furniture, cabinets, and hardwood flooring.

The graph at the bottom of this page shows the species composition of Pennsylvania's forests (top 20 species, based on number of trees 1-inch DBH and larger). Red maple is by far the most common species, accounting for 21 percent of the trees in Pennsylvania's forests. Black birch ranks second and had the largest increase since the 1989 inventory. Striped maple and eastern white pine also increased substantially.

Comparing the tree species distribution presented here to the distribution of tree species by board foot volume (see graph on last page) highlights the issue of our aging oak forest. The graph below shows decreases in oak abundance, while the graph of board foot volumes shows increases of the major oak species. One explanation is that the large oak trees present throughout the landscape continue to grow, resulting in increased board foot volumes, but oaks are not regenerating as well as other species like black birch and black cherry. This phenomenon is complex and not fully described by the first few years of inventory data. However, this analysis does show how the species composition of the forest might be changing. Additional data and more in-depth analyses of species by region and diameter-size class should help to explain species composition changes.





## Forest Regeneration is Lacking

Forests are dynamic and complex ecosystems continuously influenced by natural and human-caused disturbances, such as weather events, insects and diseases, white-tailed deer browsing, and timber harvesting. Pennsylvania's forests generally depend on natural regeneration from seed and stump sprouts. Failure to establish young trees of desired and appropriate species in advance of a disturbance allows other vegetation, such as ferns, grasses, and shrubs, to take over the forest.

Scientific evidence suggests that there is a regeneration problem in many forests across Pennsylvania due to a lack of tree seedlings. Suggested reasons for this lack include white-tailed deer overbrowsing, competition from other plants, and soil acidification. Most experts agree that all of these factors play a role in the problem, with white-tailed deer overbrowsing often cited as most significant. Since deer feed selectively, species not preferred by deer, like ferns and striped maple, have the potential to dominate the forest.

The photograph below clearly shows the impact of white-tailed deer browsing. In this example, a deer fence installed following a timber harvest protected regenerating seedlings and sprouts. The deer fence surrounds the area on the left-hand side of the picture, which contains an abundance of regeneration, compared to the area on the right-hand side, where ferns dominate or vegetation is absent. While fencing helps to protect tree seedlings, it is expensive to install and maintain and only represents a short-term fix to the problem. Reducing white-tailed deer densities represents a major step toward a long-term solution to Pennsylvania's forest regeneration problem.

## The Pennsylvania Regeneration Study

To gain a better understanding of current and future regeneration issues, the Forest Service and the Bureau of Forestry initiated *The Pennsylvania Regeneration Study*, which expands traditional FIA measurements to include detailed assessments of the forest understory.

Based on the following considerations—current white-tailed deer densities, understory conditions, and established guidelines for regenerating hardwood forests for those sites where overstory disturbance has created light conditions where regeneration

should occur—only 50 percent of the study sites had sufficient seedlings and saplings to replace the existing forest with a similar tree composition. In other words, if disturbed, such as through a windstorm, insect or disease outbreak, or timber harvest, half of Pennsylvania's forests are at risk of failing to regenerate! If this analysis includes stands with closed canopies, the outlook is even more negative.

These results paint a troublesome picture for the future of Pennsylvania's forests, and could have serious economic and ecological implications. It is appropriate to say that based on available evidence, although some

variation exists across the Commonwealth, the regeneration problem is ubiquitous and is not specific to a particular region, owner, or forest type. Forestry experts strongly recommend that tree seedlings be in place before harvesting in order to establish a new forest.

It is clear that developing a better understanding of forest ecology and succession, i.e., the interrelationships between deer, sunlight, plants, soils, and time, is critical for sustaining Pennsylvania's forests. Look for future reports to shed additional light on forest regeneration.



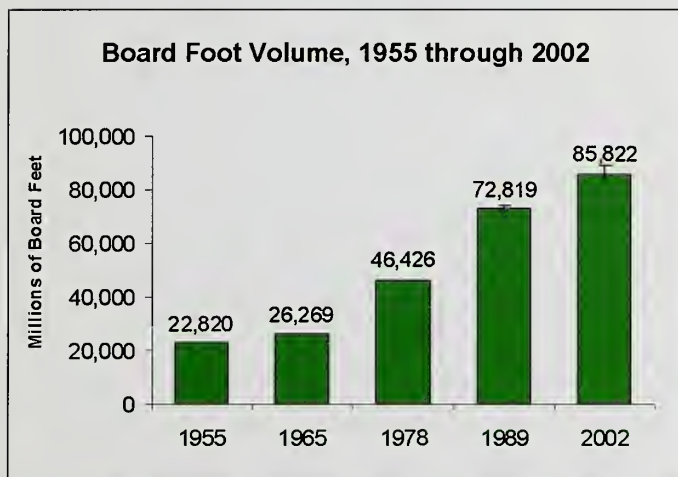
*This photograph illustrates how a woven-wire fence helped to protect forest regeneration from deer browsing following a timber harvest. The area inside and outside of the fence was harvested at the same point in time. Notice the abundance and height of the regeneration inside the fence (to the left), compared to the overall lack of regeneration outside the fence (to the right).*



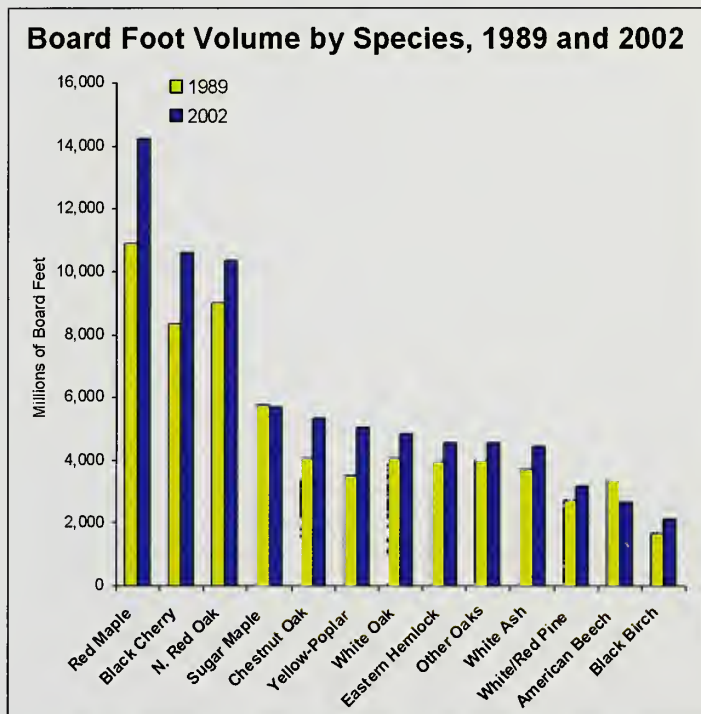
## Wood Volume Continues to Increase

The Commonwealth's forests provide raw materials for fine furniture, cabinets, hardwood flooring, paper, and more. Pennsylvania's \$5.5 billion forest products industry supports nearly 100,000 jobs.

The amount of wood in Pennsylvania's forests has increased substantially since the mid-1950s and continues to increase. Pennsylvania's forests contain approximately 86 billion board feet of lumber. This is nearly four times the volume recorded in 1955. As shown in the graph below, while the increasing trend is evident, the rate since 1989 is slower than in the previous two inventory periods. The graph to the right shows the top



tree species in board foot volume. Except for sugar maple and American beech, which have recently declined in parts of Pennsylvania, all of the major species increased in volume since the previous inventory, representing an overall 18 percent increase.



## Conclusion

While Pennsylvania is fortunate to have the largest forest resource in the State since before the mid-1800s, the latest forest inventory suggests that future forests are threatened by poor tree regeneration. If disturbed, nearly half of Pennsylvania's forests would fail to adequately regenerate into a new forest. This finding is of great concern, since the future forest depends on successful regeneration. Lack of regeneration threatens the innumerable values Pennsylvanians attribute to this resource. Most experts agree that white-tailed deer overbrowsing is the most significant factor and that management activities such as deer fencing represent only short-term fixes to the problem. Managing white-tailed deer populations at levels in balance with their habitats must occur to sustain today's forests.

Future forest conditions depend on today's decisions. We are responsible for ensuring that future generations benefit from healthy forests. The ongoing forest inventory process and other research should provide us with information necessary to make informed decisions. Look for future reports to focus on regional data and in-depth analyses on various forest conditions, which will present a clearer picture of Pennsylvania's forests.







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## Future Topics

This initial edition of *The State of the Forest Report* establishes the basis for developing future reports, which will provide new as well as updated information on topics covered in this report.

## Regeneration

Future reports will provide additional information and discussion on forest regeneration, including potential strategies for improving forest understory conditions.

## Regional Analyses

Pennsylvania is a large State with diverse and dynamic forested landscapes and thus region-specific information is critical for making informed decisions.

## Timber Availability and Accessibility

While forestland area appears stable and wood volumes are increasing, anecdotal evidence from industry experts suggests that procuring timber is becoming increasingly difficult. Understanding timber supply and availability is critical for sustaining the resource and meeting the Commonwealth's needs for forest products.

## Invasive Species

Invasive species, including both exotic and "opportunistic" native species, have the potential to disrupt the balance of entire ecosystems. Future reports will provide an indication and discussion of the severity of the problem.

## Forest Growth and Harvest Volumes

The FIA program is re-measuring plots from the 1989 inventory, which will provide vital information on changes in forest growth and harvest volumes.

## Forest Health

The FIA program began measuring forest health parameters, such as insects, diseases, and other impacts, as part of the expanded inventory. Understanding changes in ecosystem health helps forest managers and owners make informed decisions.

## Forest Ownership

Concurrent with the forest inventory is a survey of forest landowners in Pennsylvania. Understanding ownership dynamics, attitudes, and intentions is critical for developing sustainable land use policies and forest management recommendations.

## Partners

The PA Department of Conservation and Natural Resources' Bureau of Forestry and the U.S. Department of Agriculture's Forest Service developed this publication along with the following cooperating agencies and organizations:

10,000 Friends of Pennsylvania  
 Chesapeake Bay Foundation  
 Conservation and Natural Resources Advisory Council  
 Pennsylvania Audubon Society  
 Pennsylvania Environmental Council  
 Pennsylvania Hardwoods Development Council  
 Pennsylvania Game Commission  
 Penn State School of Forest Resources Cooperative Extension  
 Pennsylvania Forest Products Association  
 Sustainable Forestry Initiative of Pennsylvania  
 The Nature Conservancy  
 Western Pennsylvania Conservancy

For further information or to receive a copy of the full inventory report, please contact your local Service Forester or DCNR at:

PA DCNR  
 Bureau of Forestry  
 6th Floor, Rachel Carson State Office Building  
 P.O. Box 8552  
 Harrisburg, PA 17105-8552  
 717-787-2703  
[www.dcnr.state.pa.us](http://www.dcnr.state.pa.us)

Commonwealth of Pennsylvania,  
 Edward G. Rendell, Governor

Department of Conservation and Natural Resources,  
 Michael DiBerardinis, Secretary

Bureau of Forestry, James R. Grace, Director

Front and back cover photos by William McWilliams

